

## SPECIFICATION

### TITLE OF THE INVENTION

SHIFT CONTROL APPARATUS OF AUTOMATIC VEHICLE TRANSMISSION

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### TECHNICAL FIELD OF THE INVENTION

The present invention relates to a shift control apparatus of an automatic transmission mounted on a vehicle, and more particularly to an operative technology applied to a shift control apparatus of an automatic transmission which transmits and interrupts a power with respect to an input shaft via an input clutch.

### BACKGROUND OF THE INVENTION

15 A manual type transmission (MT) executing a shift operation on the basis of a manual operation by a driver has an input shaft which is connected to an engine and to which a plurality of drive gears are attached, and an output shaft to which a plurality of driven gears forming pairs together with the driver gears are attached and which is connected to a drive wheel. A plurality of transmission gear trains are provided between the input shaft and the output shaft. In this MT, a shift motion, that is, a shift change is executed by changing any one of the transmission gear trains by a changing mechanism such as a manually operated synchromesh mechanism or the like after disengaging the input clutch, and again engaging the input clutch.

In the case that the shift change is executed by using a

hydraulically driven shift actuator, the automatic transmission on the basis of the MT can be achieved. This type of automatic transmission (an automated manual transmission, abbreviated as an AMT) having a plurality of transmission gear trains can reduce a number of parts so as to easily achieve a weight saving in comparison with a normal torque converter type automatic transmission (AT) having a planetary gear or the like in an automatic transmission mechanism, and has an advantage that a transmission efficiency of a drive system is high.

As the AMT type automatic transmission as shown in Japanese Patent Application Laid-open No. 2001-227599, there has been developed a structure provided with a bypass clutch for transmitting the power from the input shaft to the output shaft at a time of changing gears. In accordance with the automatic transmission, it is possible to avoid a torque break during the shift change by transmitting the power from the input shaft to the output shaft with using the bypass clutch. In other words, it is possible to reduce a decline of a driving torque during the shift change, and it is possible to achieve an improvement of a shift quality.

Two shifting methods are employed in the AMT type automatic transmission. At first, as one shifting method, there is a method of automatically the same shifting method as that of the MT, namely the shifting method preformed by disengaging the input clutch. In the case of executing the shift change from a first speed to a second speed by using the shifting method, the transmission gear trains are changed from

the first speed to the second speed in a state in which the input clutch is disengaged, and the input clutch is engaged again after synchronizing an engine speed with an input shaft rotational speed in accordance with a half clutch control of  
5 the input clutch or an on-off control of an electronic controlled throttle.

Further, as another shifting method, there is the above-mentioned method using the bypass clutch, namely the method performed in the state where the input clutch is engaged. In  
10 the case that the shift change is executed from the first speed to the second speed by using this shifting method, after the driving torque applied to the first speed is reduced due to the engagement of the bypass clutch, the first speed of the transmission gear trains is changed into a neutral state.  
15 Then, by further increasing an engaging force of the bypass clutch, the input shaft rotational speed is synchronized with a rotational speed corresponding to the second speed. After the transmission gear trains are changed from the neutral state to the second speed, the bypass clutch is disengaged.  
20 In this case, even in the automatic transmission employing the shifting method using the bypass clutch, the shifting method using the input clutch is executed in correspondence to a selection of the driver and a running condition of the vehicle.

However, in the shifting method using the input clutch  
25 among the above two methods, since the input clutch is temporarily disengaged, the torque break is generated with respect to the drive wheel. In general, a starting condition of the automatic transmission is determined on the basis of a

map in which a vehicle speed and a throttle opening degree are set as a parameter, however, in the case that the automatic transmission using the input clutch is started in the course of turning around a point of intersection or the like, there is a risk that a fluctuation of a turning property such as an under-steering, an over-steering or the like is generated due to the disengagement of the input clutch, and there is a risk that an unstableness of the vehicle motion is generated.

#### SUMMARY OF THE INVENTION

An object of the present invention is to provide a shift control apparatus of an automatic transmission structured such as to improve a driving stability in the course of turning of a vehicle.

In accordance with a first aspect of the present invention, there is provided a shift control apparatus of an automatic vehicle transmission comprising: an input shaft provided with a plurality of drive gears; an output shaft arranged in parallel to the input shaft and provided with a plurality of driven gears engaging with the drive gears so as to form transmission gear trains; an input clutch arranged between an engine and the input shaft and changed into an engaged state for transmitting a power to the input shaft and a disengaged state for interrupting the power; a changing mechanism changing any one of the transmission gear trains into a power transmission state; a steering angle detecting means for detecting a steering angle of a wheel; and an input clutch control means for outputting a disengagement signal to

the input clutch in the case that the steering angle is less than an allowable value and inhibiting an output of the disengagement signal in the case that the steering angle is more than the allowable value, at a time of executing a gear-shift operation, wherein, in the case that the steering angle is more than the allowable value, the gear-shift operation in a state that the input clutch is disengaged is inhibited.

In accordance with a second aspect of the present invention, there is provided a shift control apparatus of an automatic vehicle transmission as recited in the first aspect, further comprising: a bypass clutch arranged between the input shaft and the output shaft and changed into an engaged state for transmitting a power from the input shaft to the output shaft and a disengaged state for interrupting the power at a time of executing the gear-shift operation, wherein the input clutch control means inhibits the gear-shift operation in a state that the input clutch is disengaged, by inhibiting the output of the disengagement signal applied to the input clutch, in the case that there is judged the shifting operation in which the steering angle is more than the allowable value and the bypass clutch is not engaged.

In accordance with a third aspect of the present invention, there is provided a shift control apparatus of an automatic vehicle transmission as recited in any one of the aspects mentioned above, further comprising: a vehicle speed detecting means for detecting a vehicle speed, wherein the allowable value is set in correspondence to the vehicle speed.

In accordance with a fourth aspect of the present

invention, there is provided a shift control apparatus of an automatic vehicle transmission as recited in any one of the aspects mentioned above, further comprising: a rotational speed estimating means for estimating an engine speed at a  
5 time of maintaining a transmission speed range, wherein the input clutch control means inhibits the gear-shift operation in a state that the input clutch is disengaged, by inhibiting the output of the disengagement signal applied to the input clutch, in the case that the steering angle is more than the  
10 allowable value and the engine speed is within an allowable range.

In accordance with the shift control apparatus of the automatic transmission on the basis of the present invention, since the structure is made such that the shifting operation  
15 is inhibited in a state in which the input clutch is disconnected, in the case that the vehicle is in a predetermined turning state, by judging a magnitude of the steering angle, it is possible to avoid a decline of the driving torque in the course of turning, and it is possible to  
20 improve a driving stability of the vehicle.

Further, since the structure is made such that the allowable value is changed in correspondence to the vehicle speed, it is possible to set the steering angle inhibiting the clutch disengagement shift in correspondence to the vehicle  
25 speed range. Accordingly, in the vehicle speed range in which the shifting operation is inhibited in a state in which the input clutch is disconnected, it is possible to securely execute a normal shifting operation in accordance with a

shifting property map.

Further, since the structure is made such that the engine rotational speed in the case of maintaining the transmission speed range is estimated, and it is comparatively  
5 judged whether or not the engine is within the allowable range, it is possible to avoid a trouble in view of traveling due to the inhibition of the gear-shift operation.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

10 FIG. 1 is a skeleton view showing an automatic transmission which is controlled by a shift control apparatus in accordance with an embodiment of the present invention;

FIG. 2 is a block diagram showing a hydraulic control system;

15 FIG. 3 is a flow chart showing an example of a shift judging procedure in an automatic shift control;

FIG. 4 is a flow chart showing another example of the shift judging procedure in the automatic shift control;

20 FIG. 5 is a flow chart showing the other example of the shift judging procedure in the automatic shift control;

FIG. 6 is a flow chart showing another example of the shift judging procedure in the automatic shift control;

FIG. 7 is a flow chart showing another example of the shift judging procedure in the automatic shift control; and

25 FIG. 8 is a flow chart showing another example of the shift judging procedure in the automatic shift control.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will be in detail given below of an embodiment in accordance with the present invention with reference to the accompanying drawings.

5        FIG. 1 is a skeleton view showing an automatic transmission 10 which is controlled by a shift control apparatus in accordance with an embodiment of the present invention. The automatic transmission 10 has an input shaft 12 connected to an engine 11, and an output shaft 14 arranged  
10 in parallel to the input shaft 12 and connected to a drive wheel 13. The input shaft 12 and the output shaft 14 are incorporated in a transmission case (not shown), and the automatic transmission 10 is arranged horizontally and is applied to a front wheel drive vehicle.

15        An input clutch 15 is provided between the engine 11 and the input shaft 12, and the input clutch 15 is changed into an engaged state for transmitting an engine power to the input shaft 12 and a disengaged state for interrupting the engine power in accordance with a hydraulic control. The input  
20 clutch 15 is provided with a pressure plate 18 which is mounted to a crank shaft 17 of the engine 11 via a flywheel 16, and with a clutch disc 19 which is mounted to the input shaft 12. The pressure plate 18 is pressed against the clutch disc 19 by a clutch spring, and the pressing against the clutch  
25 disc 19 is cancelled by a hydraulically driven release fork. In other words, the engine power is transmitted to the input shaft 12 by engaging the pressure plate 18 and the clutch disc 19 on the basis of a spring force, and the transmission of the



engine power is interrupted by actuating the release fork so as to cancel the engagement. In this case, the illustrated input clutch 15 is of a single disc type, however, a multiple disc type input clutch may be employed.

5           A first speed drive gear 21 and a second speed drive gear 22 are fixed to the input shaft 12, and third speed to fifth speed drive gears 23 to 25 are rotatably attached to the input shaft 12. On the other hand, a first speed driven gear 31 and a second speed driven gear 32 are rotatably attached to  
10 the output shaft 14, and third speed to fifth speed driven gears 33 to 35 are fixed to the output shaft 14. The drive gears 21 to 25 are respectively engaged with the corresponding driven gears 31 to 35 so as to form transmission gear trains in forward moving stages. When any one of a plurality of  
15 transmission gear trains is changed to a power transmission state, the automatic transmission 10 is changed to a transmission speed range in correspondence to the transmission gear train, and the output shaft 14 is driven to rotate on the basis of a driving torque in correspondence to the  
20 transmission speed range.

          The output shaft 14 is provided with a first changing mechanism 41 for changing the transmission speed range to any one of a first speed and a second speed. Further, the input shaft 12 is provided with a second changing mechanism 42 for  
25 changing the transmission speed range to any one of a third speed and a fourth speed, and a third changing mechanism 43 for changing the transmission speed range to a fifth speed. In this case, the structure may be made such that the input

shaft 12 is provided with the first changing mechanism 41, and the output shaft 14 is provided with the second and third changing mechanisms 42 and 43, or that the input shaft 12 or the output shaft 14 is provided with all the changing  
5 mechanisms 41 to 43. The switching mechanisms 41 to 43 are constituted by a synchromesh mechanism.

The first changing mechanism 41 has a synchro hub 41a which is arranged between the first speed and second speed driven gears 31 and 32 and is fixed to the output shaft 14,  
10 and a synchro sleeve 41b which is always engaged with the synchro hub 41a. When engaging the synchro sleeve 41b with a spline 31a integrally formed with the driven gear 31, the first speed transmission gear train is changed to a power transmission state, and when engaging the synchro sleeve 41b  
15 with a spline 32a integrally formed with the driven gear 32, the second speed transmission gear train is changed to a power transmission state.

The second changing mechanism 42 has a synchro hub 42a which is arranged between the third speed and fourth speed  
20 drive gears 23 and 24 and is fixed to the input shaft 12, and a synchro sleeve 42b which is always engaged with the synchro hub 42a. When engaging the synchro sleeve 42b with a spline 23a integrally formed with the drive gear 23, the third speed transmission gear train is changed to a power transmission  
25 state, and when engaging the synchro sleeve 42b with a spline 24a integrally formed with the drive gear 24, the fourth speed transmission gear train is changed to a power transmission state.

The third changing mechanism 43 has a synchro hub 43a which is arranged in adjacent to the fifth speed drive gear 25 and is fixed to the input shaft 12, and a synchro sleeve 43b which is always engaged with the synchro hub 43a. When  
5 engaging the synchro sleeve 43b with a spline 25a integrally formed with the drive gear 25, the fifth speed transmission gear train is changed to a power transmission state. In this case, these changing mechanisms 41 to 43 can be actuated to a neutral state in which the synchro sleeves 41b to 43b and the  
10 splines 31a, 32a and 23a to 25a are not engaged with each other.

A drive gear 26 for a backward movement is fixed to the input shaft 12, a driven gear 36 for a backward movement is mounted to the output shaft 14 via the synchro sleeve 41b, and  
15 the gears 26 and 36 are engaged with each other via an idler gear 45 which is rotatably provided in an idler shaft 44. The idler gear 45 is attached to the idler shaft 44 so as to freely move to a position in which the idler gear 45 engages with the gear and a position in which the engagement is  
20 cancelled. When moving the idler gear 45 in an axial direction by a changing mechanism (not shown) and engaging the drive gear 26 with the driven gear 36 via the idler gear 45, the transmission gear train of the backward moving stage is changed to a power transmission state.

25 As mentioned above, the power transmitted to the output shaft 14 via each of the transmission gear trains is transmitted to a differential gear 47 via a reduction gear 46 fixed to an end portion of the output shaft 14. Further, the

power is distributed to the right and left drive wheels 13 via the differential gear 47, and the drive wheels 13 are driven to rotate on the basis of a driving torque in correspondence to each of the transmission gear trains.

5 Further, an intermediate shaft 48 is provided in parallel to the input shaft 12, and an output gear 49 engaging with the fifth speed drive gear 25 is fixed to the intermediate shaft 48. A bypass clutch 50 is provided in the intermediate shaft 48, and the bypass clutch 50 is changed  
10 into an engaged state for transmitting the power from the input shaft 12 to the output shaft 14 and into a disengaged state for interrupting the engagement in accordance with a hydraulic control. The bypass clutch 50 is provided with a clutch hub 51 fixed to the output gear 49, and a clutch drum  
15 52 rotatably arranged in the intermediate shaft 48. An input gear 53 is fixed to the clutch drum 52, and the input gear 53 is provided so as to be engaged with an input gear 54 fixed to an end portion of the input shaft 12.

A plurality of clutch plates 51a and 52a are  
20 incorporated between the clutch hub 51 and the clutch drum 52, and a hydraulic piston 55 is received in the clutch drum 52. The bypass clutch 50 is changed into the engaged state by pressing the clutch plates 51a and 52a each other via the hydraulic piston 55, and is changed into the disengaged state  
25 by releasing the pressing. A total gear ratio of the gear trains for connecting the input shaft 12 to the output shaft 14 via the bypass clutch 50 is set to a gear ratio between the third speed and the fourth speed, and it is possible to

transmit the driving torque corresponding to an intermediate gear ratio between the third speed and the fourth speed to the output shaft 14 by changing the bypass clutch 50 to the engaged state.

5           FIG. 2 is a block diagram showing a hydraulic control system for executing an automatic transmission. In this case, FIG. 2 is illustrated omitting a hydraulic control system used for setting the backward moving stage. As shown in FIG. 2, the hydraulic control system has a bypass clutch actuator 61  
10   for actuating the bypass clutch 50, and an input clutch actuator 62 for actuating the input clutch 15. Further, in order to change any one of a plurality of transmission gear trains to the power transmitting state, the hydraulic control system has a select actuator 63 and a shift actuator 64. A  
15   linear reciprocation of two actuators 63 and 64 is transmitted to each of the changing mechanisms 41 to 43 via a direction changing mechanism (not shown). In this case, the select actuator 63 selects any one of the changing mechanisms 41 to 43 actuated as shown by an arrow A in FIG. 2, and the shift  
20   actuator 64 actuates the selected changing mechanism 41 to 43 as shown by an arrow B so as to change the transmission gear train to the power transmitting state.

          A working fluid for driving each of the actuators 61 to 64 is supplied by an oil pump 66 driven by an electric motor  
25   65. The working fluid is supplied to the bypass clutch actuator 61 via an electromagnetic valve VA1, and the working fluid is supplied to the input clutch actuator 62 via an electromagnetic valve VA2. Further, the working fluid is

supplied to the select actuator 63 via electromagnetic valves VA3 and VA4, and the working fluid is supplied to the shift actuator 64 via electromagnetic valves VA5 and VA6.

Each of the electromagnetic valves VA1 to VA6 and the  
5 electric motor 65 is driven on the basis of a drive signal  
output from an ECU 67 corresponding to an electronic control  
unit. A discharge pressure from the oil pump 66 driven by the  
electric motor 65 is monitored by a pressure sensor 68, and a  
part of the discharged working fluid is accumulated in an  
10 accumulator 69, whereby a stabilization of a line pressure is  
achieved. Further, even in the case that a trouble such as a  
malfunction of the oil pump 66, an oil leakage or the like is  
generated in the hydraulic system, a minimum emergency  
operation can be secured by the pressure accumulated in the  
15 accumulator 69. In this case, the oil pump 66 may be driven  
by an engine power.

Various signals are input to the ECU 67 from various  
sensors and switches. As the various sensors and switches,  
there are provided a steering angle sensor 70, an acceleration  
20 sensor 71, a wheel rotational speed sensor 72, a throttle  
opening degree sensor 73, an engine rotational speed sensor 74,  
an input shaft rotational speed sensor 75, an output shaft  
rotational speed sensor 76, an inhibitor switch 77 and the  
like. The ECU 67 detects a vehicle condition on the basis of  
25 the various signals input thereto, and outputs a control  
signal to each of the electromagnetic valves VA1 to VA6 as  
occasion demands.

In other words, the ECU 67 constitutes a bypass clutch

control means and an input clutch control means, and can  
change the bypass clutch 50 and the input clutch 15 into the  
engaged state and the disengaged state by outputting an  
engagement signal and a disengagement signal to the  
5 electromagnetic valve VA1 and the electromagnetic valve VA2.  
In this case, an electromagnetic pressure control valve is  
used as the electromagnetic valve VA1 and the electromagnetic  
valve VA2, and it is possible to form a half clutch state (a  
sliding control state) in addition to the changing operation  
10 of the bypass clutch 50 and the input clutch 15 between the  
engaged state and the disengaged state.

A description will be given below of an automatic shift  
control using the hydraulic control system shown in FIG. 2.  
First, when a driving range is selected in accordance with an  
15 operation of a select lever (not shown) by a driver from a  
stopping state of the vehicle, the select actuator 63 and the  
shift actuator 64 are driven in accordance with an output of  
the control signal from the ECU 67, and the first changing  
mechanism 41 is changed, whereby the transmission speed range  
20 is set to the first speed. Next, when a brake pedal is  
released and an accelerator pedal is stepped on, the input  
clutch actuator 62 driven on the basis of the output of the  
engagement signal from the ECU 67, and the input clutch 15 is  
changed into the engaged state, whereby the vehicle starts  
25 driving. In this case, the operation of the selector lever is  
input to the ECU 67 via the inhibitor switch 77.

A shifting property map obtained by employing a vehicle  
speed, a throttle opening degree and the like as a parameter

is stored in the ECU 67, the transmission speed range is set in correspondence to the vehicle speed and the throttle opening degree in the course of driving. For example, when the vehicle speed of the vehicle which is started on the basis of the first speed is increased, the ECU 67 determines a shift up to the second speed in accordance with the shifting property map. Sequentially, the shift actuator 64 is driven on the basis of the control signal output from the ECU 67, and the first changing mechanism 41 is changed, whereby the transmission speed range is set to the second speed. As mentioned above, the ECU 67 determines the transmission speed range in correspondence to the vehicle condition in accordance with the shifting property map, and appropriately executes a shift up and a shift down for the transmission speed range.

In this case, the vehicle speed is computed by the ECU 67 corresponding to the vehicle speed detecting means on the basis of the output signals from the wheel rotational speed sensor 72 and the output shaft rotational speed sensor 76, and the throttle opening degree and the engine speed are input to the ECU 67 from the throttle opening degree sensor 73 and the engine speed sensor 74.

As a shifting method at a time of executing the above-mentioned shift change, there are set two shifting methods comprising a clutch engagement shifting method of executing a shifting operation while changing the bypass clutch 50 into the engaged state in a state of maintaining the input clutch 15 in the engaged state, and a clutch disengagement shifting method of executing the shifting operation while changing the



input clutch 15 into the disengaged state. In this case, it is determined by the ECU 67, in correspondence to the vehicle condition as mentioned below, which of the two shifting methods is used.

5           First, a description will be given of a shifting process of the clutch engagement shifting. For example, in the case of shifting up from the first speed to the second speed, the bypass clutch 50 starts being engaged step by step while maintaining the engaged state of the input clutch 15.

10           Accordingly, the power transmitted to the output shaft 14 via the bypass clutch 50 is increased step by step while the power transmitted to the output shaft 14 via the first speed transmission gear train is reduced step by step. Next, the engagement between the synchro sleeve 41b and the spline 31a  
15           is disconnected in a state in which the power transmitted via the first speed transmission gear train is reduced, and the first changing mechanism 41 is changed into a neutral state. Accordingly, the fastening force of the bypass clutch 50 can be further increased.

20           At this time, since the bypass clutch 50 can transmit the power on the basis of the driving torque corresponding to the intermediate gear ratio between the third speed and the fourth speed, the engine speed with increasing in driving at the first speed is decreased for the speed corresponding to  
25           the intermediate gear ratio. At a time when the engine speed reaches that corresponding to the second speed, the first changing mechanism 41 is changed into the second speed side, and the bypass clutch 50 is disengaged step by step.

Further, in the case of shifting down to the first speed from the second speed, the bypass clutch 50 is engaged in the same manner. Accordingly, it is possible to transmit the driving torque via the bypass clutch 50 in the neutral state of the changing mechanisms 41 to 43 in which the decline of the driving torque may be generated in the course of shifting, and it is possible to obtain a good shift feeling. In this case, the clutch engagement shifting is effective particularly in the low speed range in which a difference in driving torque tends to be generated after shifting, however, the decline of the driving torque can be reduced by engaging the bypass clutch 50 even at a time of shifting to the other transmission speed ranges than the first speed and the second speed.

Subsequently, a description will be given of a shifting process of the clutch disengagement shifting. For example, in the case of shifting up to the second speed from the first speed, the input clutch 15 is first changed into the disengaged state, and the first changing mechanism 41 is changed into the second speed side via the neutral state. Subsequently, the input clutch 15 and the electronically controlled throttle are controlled, and the input clutch 15 is changed into the engaged state after synchronizing the engine speed with the input shaft rotational speed corresponding to the second speed.

Further, in the case of shifting down to the first speed from the second speed, the input clutch 15 is changed to the disengaged state in the same manner, the first changing mechanism 41 is changed into the first speed side via the

neutral state, thereafter the engine speed is synchronized with the input shaft rotational speed corresponding to the first speed, and the input clutch 15 is changed into the engaged state. In this case, the shifting operation in accordance with the same process is executed at a time of shifting to the other transmission speed ranges than the first speed and the second speed.

It is determined in accordance with the shifting program stored in the ECU 67 corresponding to the shifting operation judging means which of the clutch engagement shifting and the clutch disengagement shifting is used for executing the shifting operation. The shifting program determines which of the clutch engagement shifting and the clutch disengagement shifting should be used in correspondence to the vehicle condition, the clutch engagement shifting is employed in the case that the accelerator pedal is stepped on by the driver, and the clutch disengagement shifting is employed in the case that the accelerator pedal is not stepped on. In this case, the vehicle condition is not limited to a matter whether or not the accelerator pedal is stepped on, may be determined on the basis of various parameters such as the vehicle speed, the engine speed, the throttle opening degree and the like, or may be judged in a compositive manner by using the parameters.

A description will be given below of a procedure of judging the shifting by the shift control apparatus. FIG. 3 is a flow chart showing an example of the shift judging procedure in the automatic shift control. First, as shown in a step S1, it is judged in correspondence to the vehicle

condition whether or not the shifting operation using the  
bypass clutch 50, that is, the clutch engagement shifting can  
be executed. In the case that the clutch engagement shifting  
can be executed, the step goes to a step S2, and it is judged  
5 on the basis of the current vehicle speed and throttle opening  
degree in accordance with the shifting property map whether or  
not the shifting operation is allowed. In the case that the  
shifting operation is not allowed, the step drops out of a  
routine as it is, on the other hand, in the case that the  
10 shifting operation is allowed, the step goes to a step S3, the  
clutch engagement shifting operation using the bypass clutch  
50 is executed and the transmission speed range is changed.

Further, in the case that it is judged in the step S1  
that the clutch engagement shifting can not be executed, the  
15 step goes to a step S4, and it is judged in the same manner in  
accordance with the shifting property map whether or not the  
shifting operation is allowed. In the case that the shifting  
operation is not allowed, the step drops out of the routine as  
it is, on the other hand, in the case that the shifting  
20 operation is allowed, the step goes to a step S5, and the  
allowable value previously set on the basis of tests or the  
like and stored in the ECU 67 and the current steering angle  
are comparatively judged.

In this case, the steering angle judged in the step S5  
25 is a steering angle of the wheel, and is detected by the ECU  
67 corresponding to the steering angle detecting means on the  
basis of the output signals from the steering angle sensor 70,  
the acceleration sensor 71, the wheel rotational speed sensor

72 and the like. For example, since the rotational angle of the steering shaft is detected from the steering angle sensor 70, it is possible to directly detect the steering angle of the wheel. Further, since the acceleration in a width  
5 direction of the vehicle is detected from the acceleration sensor 71, it is possible to indirectly detect the steering angle of the wheel on the basis of the turning state of the vehicle, and since the difference in rotational speed between the right and left wheels and the front and rear wheels, that  
10 is, the wheel speed ratio can be detected from the wheel rotational speed sensor 72, it is possible to indirectly detect the steering angle of the wheel on the basis of the turning state of the vehicle.

In the case that the steering angle is less than the  
15 allowable value in the step S5, that is, in the case that it is judged that the vehicle is in a straight driving state or a gentle turning state, the step goes to a step S6, the clutch disengagement shifting is executed, and the transmission speed range is changed. On the other hand, in the case that the  
20 steering angle is more than the allowable value, that is, in the case that it is judged that the vehicle is in the turning state, the step goes to a step S7, and it is again judged whether or not the clutch engagement shifting can be executed. In the case that the clutch engagement shifting can be  
25 executed, the step goes to the step S3, the clutch engagement shifting is executed, and the transmission speed range is changed. On the other hand, in the case that the clutch engagement shifting can not be executed, the step goes to a

step S8, the output of the releasing signal to the input clutch 15 from the ECU 67 corresponding to the input clutch control signal is inhibited, and the shifting operation in a state in which the input clutch 15 is disengaged, that is, the clutch disengagement shifting is inhibited.

As mentioned above, since the structure is made such that the shifting operation in the state in which the input clutch 15 is disconnected is inhibited, in the case that the vehicle is in a predetermined turning state, by judging a magnitude of the steering angle, it is possible to avoid the decline of the driving torque in the course of turning, and it is possible to improve a driving stability of the vehicle. For example, even in the condition of traveling with a small turning radius such as traveling around a point of intersection, it is possible to avoid a destabilization in a vehicle motion such as an under steer and an over steer.

FIG. 4 is a flow chart showing another example of the shift judging procedure in the automatic shift control. This flow chart corresponds to a flow chart in which the allowable value to be compared in the step S5 in FIG. 3 is changed in correspondence to the vehicle speed. In this case, in FIG. 4, the same reference numerals are attached to the common steps with those in FIG. 3, and a description thereof will be omitted.

As shown in FIG. 4, in the case that it is judged in the step S1 that the clutch engagement shifting can not be executed, and the shifting operation is allowed in the step S4, the current steering angle and the allowable value changing in

correspondence to the vehicle speed are comparatively judged in the succeeding step S10. In this case, an allowable value table obtained by setting the vehicle speed as the parameter is stored in the ECU 67, and the allowable value to be  
5 compared is selected from the allowable value table in correspondence to the vehicle speed. In this case, the allowable value within the allowable value table is set to be larger in accordance with an increase of the vehicle speed.

In the case that the steering angle is less than the  
10 selected allowable value in the step S10, the step goes to the step S6, the clutch disengagement shifting is executed and the transmission speed range is changed. On the other hand, in the case that the steering angle is more than the allowable value, the step goes to the step S7 and it is again judged  
15 whether or not the clutch engagement shifting can be executed. In the case that the clutch engagement shifting can be executed, the step goes to the step S3, the clutch engagement shifting is executed and the transmission speed range is changed. On the other hand, in the case that the clutch  
20 engagement shifting can not be executed, the step goes to the step S8, the disengaging signal is inhibited from being output from the ECU 67 to the input clutch 15, and the shifting operation in the state in which the input clutch 15 is disengaged, that is, the clutch disengagement shifting is  
25 inhibited.

As mentioned above, since the structure is made such that the allowable value is changed in correspondence to the vehicle speed, it is possible to set the allowable value,

namely the steering angle, for inhibiting the clutch disengagement shifting in correspondence to the vehicle speed range. In particular, since it is possible to avoid the inhibition of the shifting operation in the automatic shift control in the high vehicle speed range, by setting such that the allowable value is increased in accordance with the increase of the vehicle speed, it is possible to securely execute the shift up for executing a favorable mileage driving in the high vehicle speed range, the shift down for re-acceleration and the like in accordance with the shifting property map.

FIG. 5 is a flow chart showing the other example of the shift judging procedure in the automatic shift control. This flow chart corresponds to a flow chart in which the engine speed is comparatively judged between the step 7 and the step 8 in FIG. 3. In this case, in FIG. 5, the same reference numerals are attached to the common steps with those in FIGs. 3 and 4, and a description thereof will be omitted.

As shown in FIG. 5, in the case that it is judged in the step S1 that the clutch engagement shifting can not be executed, and the shifting operation is allowed in the step S4, it is judged in the succeeding step S10 that the steering angle is less than the allowable value, and it is judged again in the step S7 that the clutch engagement shifting can not be executed, the engine speed in the case of maintaining the transmission speed range is judged in the succeeding step S20.

The engine speed to be judged in the step S20 is an engine speed which is estimated in the case that the



transmission speed range is maintained, that is, the shifting operation is not executed. The ECU 67 corresponding to the rotational speed estimating means comprehensively perform an arithmetical operation in accordance with the current engine speed input from the engine speed sensor 74, the current vehicle speed computed on the basis of the signals input from the wheel rotational speed sensor 72 and the output shaft rotational speed sensor 76, the acceleration in the forward moving direction input from the acceleration sensor 71, the current transmission speed range and gear ratio stored in the ECU 67, and the like, and estimates the engine speed in the case of maintaining the transmission speed range.

Further, the allowable range of the engine speed previously set in accordance with the test or the like is stored in the ECU 67, and the ECU 67 comparatively judges the estimated engine speed and the stored allowable range. In this case, the stored allowable range is defined as the engine speed in which no trouble is generated in the driving. For example, in the case that there is a risk that the engine speed is lowered so as to generate an engine stall by maintaining the transmission speed range, or in the case that there is a risk that the engine speed is increased so as to generate an over rev of the engine 11, the engine speed deflects from the allowable range.

In the step S20, in the case that the estimated engine speed deflects from the allowable range and it is recognized that there is a risk that the engine stall or the over rev is generated, the step goes to the step S3, the clutch

disengagement shifting is executed, and the transmission speed range is changed. On the other hand, it is recognized that there is no risk because the estimated engine speed is within the allowable range, the step goes to the step S8, the  
5 disengagement signal is inhibited from being output from the ECU 67 to the input clutch 15, and the shifting operation in the state in which the input clutch 15 is disengaged, that is, the clutch disengagement shifting is inhibited.

As mentioned above, since the structure is made such as  
10 to estimate the engine speed in the case of maintaining the transmission speed range without executing the shifting operation and comparatively judge the estimated engine speed and the allowable range of the engine speed stored in the ECU 67, it is possible to allow the shifting operation in the case  
15 that any trouble is generated in the traveling due to the inhibition of the shifting. Accordingly, it is possible to avoid the generation of the engine stall and the over revolution due to the inhibition of the shifting operation. For example, even in the case that the vehicle speed is  
20 lowered due to the point of intersection or the like, it is possible to safely apply the shift inhibiting control in correspondence to the steering angle.

As described above, the shifting judgment executed in accordance with the flow charts in FIGs. 3 to 5 is applied to  
25 the automatic transmission 10 shown in FIG. 1, that is, the automatic transmission 10 provided with the input clutch 15 and the bypass clutch 50, however, it is possible to apply the shifting judgment achieved by the shift control apparatus in

accordance with the present invention to an automatic transmission having no bypass clutch 50.

A description will be given below of a procedure of a shifting judgment achieved by the shift control apparatus of the automatic transmission having no bypass clutch 50. As a hydraulic control system provided in the shift control apparatus of the automatic transmission, there is employed a hydraulic control system obtained by removing the electromagnetic valve VA1 and the bypass clutch actuator 61 from the hydraulic control system shown in FIG. 2. Further, since the automatic transmission is provided with the bypass clutch 50, only the clutch disengagement shifting mentioned above is executed as the shifting method.

FIG. 6 is a flow chart showing an example of the shift judging procedure in the automatic shift control. In FIG. 6, the same reference numerals are attached to the common steps with those in FIG. 3, and a description thereof will be omitted. As shown in FIG. 6, in the case that the shifting operation is not allowed in the step S4, the step goes to the step S8 and the step drops out of the routine without executing the shifting operation. On the other hand, in the case that the shifting operation is allowed, the step goes to the step S5, and the allowable value and the steering angle are comparatively judged.

In the case that the steering angle is less than the allowable value in the step S5, the step goes to the step S6, the clutch disengagement shifting is executed, and the transmission speed range is changed. On the other hand, in

the case that the steering angle is more than the allowable value, the step goes to the step S8, the disengagement signal is inhibited from being output from the ECU 67 to the input clutch 15, and the shifting operation in the state in which  
5 the input clutch 15 is disengaged, that is, the clutch disengagement shifting is inhibited.

FIG. 7 is a flow chart showing the other example of the shift judging procedure in the automatic shift control. In FIG. 7, the same reference numerals are attached to the common  
10 steps with those in FIG. 4, and a description thereof will be omitted. As shown in FIG. 7, in the case that the shifting operation is not allowed in the step S4, the step goes to the step S8 and the step drops out of the routine without executing the shifting operation. On the other hand, in the  
15 case that the shifting operation is allowed, the step goes to the step S10, and the allowable value changing in correspondence to the vehicle speed and the current steering angle are comparatively judged.

In the case that the steering angle is less than the  
20 allowable value in correspondence to the vehicle speed in the step S5, the step goes to the step S6, the clutch disengagement shifting is executed, and the transmission speed range is changed. On the other hand, in the case that the steering angle is more than the allowable value in  
25 correspondence to the vehicle speed, the step goes to the step S8, the disengagement signal is inhibited from being output from the ECU 67 to the input clutch 15, and the shifting operation in the state in which the input clutch 15 is

disengaged, that is, the clutch disengagement shifting is inhibited.

FIG. 8 is a flow chart showing the other example of the shift judging procedure in the automatic shift control. In FIG. 8, the same reference numerals are attached to the common steps with those in FIG. 5, and a description thereof will be omitted. As shown in FIG. 8, in the case that the shifting operation is not allowed in the step S4, the step goes to the step S8 and the step drops out of the routine without executing the shifting operation. On the other hand, in the case that the shifting operation is allowed, the step goes to the step S10, and the allowable value changing in correspondence to the vehicle speed and the current steering angle are comparatively judged.

In the case that the steering angle is less than the allowable value in correspondence to the vehicle speed in the step S10, the step goes to the step S6, the clutch disengagement shifting is executed, and the transmission speed range is changed. On the other hand, in the case that the steering angle is more than the allowable value in correspondence to the vehicle speed, the engine speed in the case of maintaining the transmission speed range is judged in the succeeding step S20.

In the step S20, in the case that the engine speed estimated by the ECU 67 and the allowable range stored in the ECU 67 are comparatively judged, and it is recognized that there is a risk that the engine stall or the over revolution is generated, the step goes to the step S3, the clutch

disengagement shifting is executed, and the transmission speed range is changed. On the other hand, it is recognized that there is no risk because the estimated engine speed is within the allowable range, the step goes to the step S8, the  
5 disengagement signal is inhibited from being output from the ECU 67 to the input clutch 15, and the shifting operation in the state in which the input clutch 15 is disengaged, that is, the clutch disengagement shifting is inhibited.

As mentioned above, even in the automatic transmission  
10 in which the shifting method is constituted only by the clutch disengagement shifting, since the structure is made such that the shifting operation in the state in which the input clutch 15 is disconnected is inhibited, in the case that the vehicle is in a predetermined turning state, by judging a magnitude of  
15 the steering angle, it is possible to avoid the decline of the driving torque in the course of turning, and it is possible to improve a driving stability of the vehicle. For example, even in the condition of traveling with a small turning radius such as traveling around a point of intersection, it is possible to  
20 avoid a destabilization in a vehicle motion such as an under steer and an over steer.

Further, in the case that the structure is made such that the allowable value is changed in correspondence to the vehicle speed, it is possible to set the steering angle for  
25 inhibiting the clutch disengagement shifting in correspondence to the vehicle speed range. In particular, since the inhibition of the shifting operation is not generated in the automatic shift control in the high vehicle speed range, by

setting such that the allowable value is increased in accordance with the increase of the vehicle speed, it is possible to securely execute the shift up for executing a favorable mileage traveling in the high vehicle speed range, 5 the shift down for re-acceleration and the like in accordance with the shifting property map.

Further, since the structure is made such as to estimate the engine speed in the case of maintaining the transmission speed range and comparatively judge whether or not the engine 10 speed is within the allowable range, it is possible to allow the shifting operation in the case that any trouble is generated in the traveling due to the inhibition of the shifting. Accordingly, it is possible to avoid the generation of the engine stall and the over rev due to the inhibition of 15 the shifting operation.

The present invention is not limited to the embodiments mentioned above, and can be variously modified within the scope of the present invention. For example, the input clutch 15 and the bypass clutch 50 have a fluid pressure as a driving 20 source, however, can employ a clutch such as an electromagnetic clutch which is driven in accordance with an electric current control from the ECU 67.

Further, the illustrated automatic transmission 10 is structured for the front wheel drive mounted horizontally, 25 however, may be constituted by an automatic transmission for a rear wheel drive or a four wheel drive, or may be constituted by an automatic transmission mounted vertically. Further, the illustrated automatic transmission 10 is provided with one

bypass clutch 50, however, may be structured such that a plurality of bypass clutches 50 are provided.

In this case, in the flow charts illustrated in FIGs. 5 and 8, the allowable value changing in correspondence to the vehicle speed and the current steering angle are comparatively judged in the step S10, however, the structure may be made such that the allowable value corresponding to a fixed value and the current steering angle may be comparatively judged.

The entire disclosure of Japanese Patent Application No. 2003-87002 filed on March 27, 2003 including specification, claims, drawings and summary is incorporated herein by reference in its entirety.